MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

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W. H. M. CHRISTIE, M.A., F.R.S., President, in the Chair.

Thomas Dallmeyer, 19 Bloomsbury Street, W.C.;
Alfred Robert Johnson, M.A., St. John's College, Cambridge;
Reginald Carter Nelson, 19 Roker Terrace, Sunderland;
Sir Henry Thompson, M.B., 35 Wimpole Street, W.; and
John Walther, M.D., C.M. Edin., West House, Eastbourne,

were balloted for and duly elected Fellows of the Society.

The following candidates were proposed as Fellows of the Society, the name of the proposer from personal knowledge being appended :—

T. Bolton, Calcutta (proposed by Robert Wigglesworth);
Andrew Claude de la Cherois Crommelin, B.A., Trinity College, Cambridge (proposed by Lieut.-Col. G. L. Tupman);
Arthur Herbert Leahy, M.A., Pembroke College, Cambridge (proposed by H. H. Turner); and
Samuel Maitland Baird Gemmill, 9 Gower Street, Kelvinside, Glasgow (proposed by the Rev. A. Henderson).

Regulations for the Library.

The works in the Library are available for the use of the Fellows, with the exception of the following, which may not be taken out without special permission of the Council :—

Manuscripts.
Original drawings and photographs.
Printed books of earlier date than 1500.
Maps and charts.

Royal Society Catalogue of Scientific papers.
Dictionaries.
Nautical Almanac
Connaissance des Temps
Berliner Astronomisches Jahrbuch
Washington Ephemeris
British Association Catalogue } except duplicates.
Lalande's Catalogue
Lacaille's Catalogue
Stone's Cape Catalogue
Gould's Catalogues

Total Solar Eclipse Committee.

At a meeting of the above Committee, appointed by the Council of the R.A.S., the following resolution was passed :—

That the Council be requested to move the President to notify to the Fellows generally the constitution of this Committee, and to mention its objects of—

(1) Bringing into communication with each other gentlemen willing to observe eclipses.

(2) Becoming a centre of information for intending observers.

Note on the Total Solar Eclipse of 1889, *December* 21–22.

By J. R. Hind, LL.D., F.R.S.

In the second of the two total eclipses of the Sun occurring in the year 1889, although the track of the central line where duration of totality is longest is across the Atlantic, observations will be obtainable at three points in its course where the Sun will have an altitude of more than ten degrees.

First, at the southern extremity of the island of Trinidad, at Point Icacos, where the circumstances are:

	h	m	s	
Totality begins Dec. 21 at	19	6	27	local M.T.
Duration of totality		1	46	

Sun's altitude, 12°.

Next, at Cayenne, in French Guiana, where

	h	m	s	
Totality begins Dec. 21 at	19	51	23	local M.T.
Duration of totality		2	3	

Sun's altitude, 24°.

Again, where the central line meets the west coast of Africa, in about 13° 20′ east longitude, and 9° 42′ south latitude. At this point

	h	m	s	
Totality begins Dec. 22 at	2	56	3	local M.T.
Duration of totality		3	12	

Sun's altitude, 46°.

For any point near this the Greenwich mean time of beginning and ending of totality may be found from the formulæ,

$$\cos\omega = +8{\cdot}9188 - [1{\cdot}93737]\sin l + [1{\cdot}57729]\cos l\,.\,\cos(\lambda + 217^\circ\ 36'{\cdot}6)$$

$$t = 0^h\ 19^m\ 45^s{\cdot}5 \mp [1{\cdot}98325]\sin\omega + [2{\cdot}59376]\sin l$$
$$- [3{\cdot}95966]\cos l\,.\,\cos(\lambda + 121^\circ\ 32'{\cdot}4),$$

where l is the *geocentric* latitude, λ the longitude from Greenwich taken *positively*, and the quantities within square brackets are the logarithms of seconds of time.

The central line on entering Africa runs through the following points:

Greenwich Mean Time.		Longitude E.		Latitude S.	
h	m	°	′	°	′
2	4	13	10·3	9	45·1
2	5	13	41·3	9	34·8
2	6	14	12·7	9	24·2
2	7	14	44·5	9	13·4
2	8	15	16·9	9	2·2

Remarks on Sir George Airy's "Numerical Lunar Theory."

By Professor J. C. Adams, M.A., &c.

In the Report of the Council on the subject of Sir George Airy's "Numerical Lunar Theory," it has been explained that the large discordances which have been found by the author to result from the substitution of the values of the Moon's coordinates, as found by Delaunay, in the differential equations of motion, are caused by the large errors of Delaunay's coefficients of parallax, which Sir George has employed. It may be useful and not uninteresting to give on this subject some additional details. In the first place it will be well to prevent a possible misapprehension. In speaking of the errors of Delaunay's coefficients it is not intended to imply that there is any mistake in Delaunay's *theory*. The terms of the analytical expression for the Moon's parallax which Delaunay gives are all correct, but they only extend to the fifth order of small quantities, and are therefore not nearly precise enough to be used for the purpose to which the expression for the parallax is applied by Sir George

Airy. Delaunay intended this value of the parallax to be employed merely in reducing the apparent place of the Moon to its place as seen from the Earth's centre, and for this purpose the value is perhaps sufficiently accurate.

If the several transformations of the elements given by Delaunay in his great work had been applied to the analytical expression for the reciprocal of the radius vector, and if Delaunay had carried the developments to the same extent as he had done in the case of the Moon's longitude and latitude, the theory would have been quite competent to give the third coordinate with the same degree of precision as had been attained in the case of the two other coordinates.

The following table, which is reduced from the table given in pp. 398, 399, of vol. xliii. of the *Monthly Notices*, R.A.S., shows the proportional values of the coefficients of parallax as found by me, mainly after Pontécoulant, when compared with those employed by Sir George Airy after Delaunay.

Argt.	My Coefficient.	Delaunay's.
o	10000000,	10000000,
l	544989, 3	545145, 6
$2D-l$	100236, 0	99822, 4
$2D$	82493, 6	82329, 2
$2l$	29716, 6	29796, 4
$2D+l$	9029, 0	8950, 8
$2D-S$	5595, 6	5482, 2
$2D-l-S$	4234, 0	4243, 1
$l-S$	3380, 7	3074, 5
D	− 2773, 0	− 2739, 9
$l+S$	− 2770, 0	− 2664, 0
$2f-l$	− 2074, 6	− 2068, 25
$3l$	1835, 0	1844, 7
$4D-l$	1753, 2	1458, 2
S	− 1168, 8	− 1248, 4
$2D-l+S$	− 675, 0	− 1107, 0
$2D+S$	− 894, 1	− 957, 1
$4D-2l$	1087, 0	906, 9
$2D-2l$	− 897, 05	− 809, 3
$2D+2l$	821, 0	790, 9
$2D+l-S$	648, 7	574, 7
$4D$	759, 7	572, 6
$D+S$	423, 7	440, 3
$2D-2f$	− 309, 7	− 319, 0
$2l-S$	359, 4	300, 9

Argt.	My Coefficient.	Delaunay's.
$2D-3l$	− 338, 95	− 295, 7
$D+l$	− 309, 7	− 283, 7
$2l+S$	− 292, 2	− 267, 9
$2D-2f-l$	− 251, 3	− 238, 4
$2D-2S$	260, 05	222, 0
$2D-2f+l$	− 140, 25	− 146, 4
$2D-l-2S$	146, 1	132, 6
$4l$	119, 8	121, 0
$2D+l+S$	− 137, 3	− 117, 2
$4D-l-S$	184, 1	86, 8
$3D-l$	− 105, 2	− 58, 1
$4D+l$	93, 5	54, 05
$2D+3l$	51, 2	51,
$4D-2l-S$	87, 7	46, 5
$3D$	14, 6	46, 2
$2D+2f-2l$	− 42, 6	− 43.
$D+l+S$	38, 9	38, 9
$l-2S$	38, 3	38, 3
$2D-l+2S$	− 37, 4	− 37, 4
$2D-2l-S$	− 37, 1	− 37, 1

This table shows at a glance how great the errors of Delaunay's coefficients of parallax, when reduced to the form in which they are employed by Sir George Airy, in many cases really are. Hence the discordances which he met with in the results of the substitutions should occasion no surprise. In the Introduction to the "Numerical Lunar Theory," p 4, line 20, it is stated through inadvertence that the factor which Sir George Airy calls M is a quantity "depending on the proportion of the masses of the Earth and Moon." This is not the case however, since M is simply the ratio of the sum of the actual masses of the Earth and Moon to the sum of the masses which would be required to make the Moon describe an undisturbed orbit about the Earth in which the periodic time and the mean parallax were the same as in the actual orbit.

The theoretical value of M is simply expressed as the *cube* of the constant term in Delaunay's value of $\frac{a}{r}$. This value is given analytically in p. 802 or p. 914 of the second volume of Delaunay's Theory, but only to the fifth order of small quantities, which is not accurate enough. The development of the constant term of $\frac{a}{r}$ has been carried by me to a much greater extent at p. 472 of vol. xxxviii. of the *Monthly Notices*. Turning this expres-

sion into numbers, and cubing it, we find the value of M to be 1·0027259, which agrees very closely with the value found by Sir George Airy by comparing the constant terms on the two sides of his equation (10).

The other two ways of finding M proposed by Sir George in p. 76 of his Theory, viz. by comparing the quantities on the two sides of the equations (10) and (12), corresponding to the arguments 2 and 301 respectively, are not satisfactory, as the results will be affected by errors in the theoretical determinations of the mean motions of the Moon's perigee and node respectively.

The multiplier M, representing the sum of the masses of the Earth and Moon, must be employed wherever the mutual attraction of these two bodies comes in question. In Sir George Airy's note at p. 254 of the March number of the *Monthly Notices*, he calls M the coefficient of a *solar* term, but this is plainly a mistake. I should mention that I have already communicated the substance of this paper to Sir George Airy himself.

The Positions for 1750·0 *and Proper Motions of* 154 *Stars south of* −29° *declination deduced from a revision of Powalky's Reduction of the Star Places of Lacaille's Astronomiæ Fundamenta.* By A. M. W. Downing, M.A.

In the report of the Superintendent of the U.S. Coast and Geodetic Survey for the year ending June 1882, the late Dr. C. R. Powalky published "a new reduction of Lacaille's observations, made at the Cape of Good Hope and at Paris between 1749 and 1757, and given in his *Astronomiæ Fundamenta*, together with a comparison of the results with the Bradley-Bessel *Fundamenta*; also a catalogue of the places of 150 stars south of declination −30°, for the epochs 1750 and 1830." Powalky's catalogue thus depends on the star places of Bessel's *Fundamenta*, that is to say, the assumed right ascensions of the stars used for determination of clock error are those of the *Tabulæ Regiomontanæ* or of the *Fundamenta*, and systematic corrections to Lacaille's declinations have been determined by comparing them with the same authorities. It is the object of the present paper to deduce the necessary corrections to Powalky's places of the stars observed at the Cape, so as to make them depend on Auwers' re-reduction of Bradley, and to determine the proper motions resulting from a comparison of these corrected places with the mean for the epoch 1875 of Stone's Cape Catalogue, and Gould's Argentine General Catalogue. The various processes of reduction are not very clearly explained by Powalky, and on my writing to Professor Peters, of Clinton (who examined and reported on the paper), to ask if he could supply me with any further information, he had the great kindness to cause a search

for Powalky's MSS. to be made, a search which unfortunately proved unsuccessful. It was necessary therefore to go through some of the computations in order to ascertain how the star places used in the reductions had been deduced from Bessel's places, and as the result of this examination it appeared that the apparent places of the stars contained in the *Tabulæ Regiomontanæ*, which were used for clock error, were taken without alteration from that work (with the exception of *Sirius*, the apparent places of which were corrected for orbital motion as determined by Auwers), and that the apparent places of stars taken from the *Fundamenta* were brought back from 1755 with the annual precessions of the *Fundamenta*, without proper motion, but with "star corrections" computed from the modern elements. It has been assumed, therefore, that Powalky's "star corrections" are correct throughout (he states that the "day constants" for 1750–1757 were taken from Struve's *Tabulæ Quantitatum Besselianarum pro annis* 1750–1840), and that in bringing back the places from the *Fundamenta* he has used the precessions of the *Fundamenta*, omitting proper motions. In revising the assumed right ascensions of "clock" stars (which as well as the southern stars were observed by Lacaille at the Cape by the method of equal altitudes, using an iron 3-foot quadrant in connection with a $3\frac{1}{2}$-foot telescope and a clock of Le Roy), it was therefore necessary to compute "star corrections" for *Sirius* and for the other *Tabulæ Regiomontanæ* stars for each day on which they were observed, using the *Tabulæ Quantitatum Besselianarum pro annis* 1750–1840, and Stone's "Tables for Constants of Star Reductions" adapted to the epoch. The proper motions were, of course, taken from Auwers' Bradley, and the places of *Sirius* and *Procyon* further corrected for orbital motion in accordance with the elements determined by the same astronomer (*Publ. Ast. Ges.* No. vii., and *Ast. Nach.* No. 1373). The apparent places of the *Fundamenta* stars as given by Powalky were corrected for proper motion, difference between Bessel's and Struve's precessions, and difference between Bessel's and Auwers' reduction of Bradley. The clock errors deduced from observations of the Sun, for which the Hansen-Olufsen Solar Tables were used, have been retained unaltered. From the clock errors thus corrected the revised right ascensions of the southern stars were determined. With but two or three exceptions these were observed on one day only, and it is difficult to form an estimate as to the probable errors of the positions; from forty observations of *Sirius*, however, made on days when there was a fair independent determination of clock error, the mean right ascension for 1751·0 is $6^h\ 34^m\ 10^s{\cdot}626$, with probable error of a single determination $\pm 0^s{\cdot}182$, which should not differ much from the probable error of a Catalogue place. The maximum correction applicable to the right ascension of a southern star as reduced by Powalky is $0^s{\cdot}15$.

Observations of zenith distance were made by Lacaille at the Cape with

I. Sextant with 6-foot telescope,
II Sextant with 5-foot telescope,
III. Sector,

some details of the construction of which are given by Powalky, pp. 470, 471.

For the latitude of Lacaille's observatory at the Cape, Powalky's value ($-33^\circ\ 55'\ 15''\cdot8$) has been used. It is stated on p. 471 that the refractions have been computed from the Pulkowa tables, with "corrections for mean temperature (from Dove's tables) and barometer."

Corrections to the *Fundamenta* declinations, as given by Powalky, of the Bradley stars observed by Lacaille at the Cape have been determined in the same way as for the right ascensions, and corrections to Lacaille's three series of declinations, of the form $x \sin\delta + y \cos\delta$, deduced by the method of least squares from the comparison of Lacaille's places of these stars with the standard places, in combination with the observations of circumpolar stars observed above and below the pole. The three series of corrections, compared with the corresponding ones deduced by Powalky, are:

I.	α.	$+6''\cdot9 \sin\delta$	$+3''\cdot4 \cos\delta$
	β.	$+6\cdot04 \sin\delta$	$+3\cdot05 \cos\delta$
II.	α.	$+8\cdot33 \sin\delta$	$+4\cdot45 \cos\delta$
	β.	$+5\cdot79 \sin\delta$	$+4\cdot43 \cos\delta$
III.	α.	$+20\cdot5 \sin\delta$	$+11\cdot5 \cos\delta$
	β.	$+18\cdot29 \sin\delta$	$+10\cdot91 \cos\delta$

The figures I. II. and III. refer to the three series of declinations observed by Lacaille with his different instruments described above, and α and β are the corrections deduced by Powalky and in the present investigation respectively. The differences found between these may to some extent be due to difference of treatment. In the present investigation, for convenience of computation, the stars have been combined in groups, the correction deduced from each star place being given equal weight, independently of the number of observations on which it depends, and in I. and II. the groups have been given weights equal to the number of stars included in each, whilst in III., as the distribution of groups is unfavourable, each group has been given equal weight. It is not quite clear what course has been followed by Powalky in this part of the work. The application of these corrections gives the final catalogue declinations, which in general depend on observations made with one instrument only, but in those cases (there are ten of them) in which more

than one instrument has been used, the agreement is satisfactory, the average discordance being $2''\cdot8$, and the maximum discordance $5''\cdot7$. In combining observations made with different instruments, half weight has been given to II. From Powalky's paper, p. 475, where he gives the separate re-reduced observations of zenith distance of *α Virginis*, it appears that the probable error of a single declination observed at the Cape with the sextant (principal telescope) is $\pm3''\cdot2$, and with the sector is $\pm1''\cdot4$; the corrections of the form $x\sin\delta+y\cos\delta$ are much more satisfactorily determined for the former than for the latter, and it appeared preferable, therefore, to give the results derived from these two instruments equal weight when combining them. Powalky gives no data for determining the probable error of a declination observed with the smaller telescope on the sextant. The declinations in the Catalogue depend generally on five or six observations.

For further details of the observations and their reduction the reader is referred to Powalky's paper.

A catalogue of the places of 154 stars south of declination $-29°$ for the epoch 1750·0 having been thus formed, precessions for that epoch were computed by the help of Stone's "Tables for Constants of Star Reductions" before mentioned. With these precessions and their secular variations, deduced from comparing them with the precessions given in the Cape Catalogue for 1850, the places of the stars were brought up to 1812·5, the middle epoch between 1750·0 and 1875·0, and the precessions again computed for 1812·5. We thus have precessions for three equi-distant epochs, 1750·0, 1812·5 and 1875·0 (the latter being taken from Gould's Catalogue), and therefore the mean annual precession for the interval 1750–1875

$$=\tfrac{1}{6}(p_1+4p_2+p_3),$$

which is accurate to the fourth power of the time.

By means of the mean annual precessions computed from this formula, Lacaille's places have been brought up to 1875·0, and compared with the mean of Stone's Cape Catalogue (brought back from 1880 with the proper motions of that Catalogue), and Gould's Argentine General Catalogue, and thus the proper motions given in the following catalogue have been determined.

The same method has been followed for all the stars contained in the catalogue except *τ Octantis* (Dec. $1750=88°\ 50'$), for which the rigorous trigonometrical formulæ have been used.

Where a star in the catalogue is designated by Lacaille's number, the reference is to the number in Lacaille's Zone Catalogue of 9766 stars. The approximate places of stars observed in one element only have been taken from the same catalogue.

In the case of *α Centauri* the common proper motion has been found by comparing the mean of the places of the two components for 1750, brought up to 1875, with the mean of their places for 1875.

Star's Name.	Mean R.A. 1750·0.	Epoch 1700+.	Annual Precession 1750·0.	Annual Precession 1812·5.	Proper Motion in R.A.	Mean Dec. 1750·0.	Epoch 1700+.	Annual Precession 1750·0.	Annual Precession 1812·5.	Proper Motion in Dec.
	h m s		s	s	s	° ′ ″		″	″	″
ζ Toucani	0 6 52·12	51·77	+2·9783	+2·9406	+0·268	−66 20 45·2	52·0	+20·057	+20·041	+1·18
β Hydri	0 12 11·02	51·73	2·7152	2·6551	+0·709	78 39 50·2	51·9	20·037	20·017	+0·31
α Phœnicis	0 13 51·60	51·77	2·9926	2·9776	+0·018	43 39 57·6	51·8	20·029	20·005	−0·40
λ Phœnicis	0 19 17·30	52·86	2·9349	2·9168	+0·008	50 11 22 2	52·1	19·995	19 965	+0·03
β¹ Toucani	0 19 58·25	51·77	2·8275	2·7972	−0·002	64 20 21·2	51·6	19·989	19·960	−0·02
ξ Phœnicis	0 30 19	...	...	...	...	57 52 57·8	52·2	19·889	19·850	+0·12
η Phœnicis	0 32 1·66	51·85	2·7618	2·7402	−0·003	58 49 30	...	...	...	...
λ Hydri	0 39 50·39	51·77	2·1215	2·0967	+0·017	76 17 16·8	51·9	19·763	19·724	−0·04
β Phœnicis	0 54 52·31	51·70	2·7167	2·7047	−0·003	48 3 48·0	51·8	19·493	19·428	+0·01
ζ Phœnicis	0 57 48	...	...	...	...	56 35 18·7	51·9	19·430	19·366	+0·05
γ Phœnicis	1 17 28·18	51·70	2·6322	2·6239	0·000	44 36 27·2	51·7	18·930	18·844	−0·17
δ Phœnicis	1 20 47·92	51·70	2·5118	2·5025	+0 016	50 22 48·2	51·7	18·831	18·746	+0 19
α Eridani	1 28 22·40	51·73	2 2484	2·2397	+0·008	58 30 52·9	52·2	18·592	18·509	−0 02
χ Eridani	1 46 12·98	52·86	2·2802	2·2744	+0·067	52 51 46·2	52·3	17·949	17·851	+0·34
α Hydri	1 50 52·93	51·77	1·8594	1·8576	+0·038	62 47 36·2	52·3	17·762	17·678	+0·03
δ Hydri	2 17 23·53	51·75	1·0183	1·0375	−0·012	69 48 5·7	52·0	16·567	16·509	−0·01
κ Hydri	2 21 38·79	51·85	+0·2208	+0·2732	−0 037	74 46 46·0	52·0	16 354	16·336	0·00
μ Hydri	2 37 47·14	51·85	−1·8477	−1·6640	+0·029	80 11 38·9	52·0	15·495	15·592	−0·05
θ Eridani	2 48 47·01	51·77	+2·2799	+2·2796	−0·006	41 19 9·3	51·9	14·866	14·721	+0·05
12 Eridani	3 1 27·42	51·77	+2·5205	+2·5211	+0·025	−29 59 13·1	52·0	+14·098	+13·929	+0·66

Star's Name.	Mean R.A. 1750·0.	Epoch 1700+.	Annual Precession 1750·0.	Annual Precession 1812·5.	Proper Motion in R.A.	Mean Dec. 1750·0.	Epoch 1700+.	Annual Precession 1750·0.	Annual Precession 1812·5.	Proper Motion in Dec.
	h m s		s	s	s	° ′ ″		″	″	″
Lacaille 1244	3 39 22·69	51·92	+2·2029	+2·2045	+0·007	−38 23 58·4	52·0	+11·553	+11·385	+0·03
Lacaille 1253	3 41 10·44	51·94	+0·6456	+0·6647	+0·039	65 35 57·8	52·0	11·425	11·373	+0·12
γ Hydri	3 51 26·85	51·85	−1·1572	−1·0872	+0·008	74 59 54·4	52·0	10·674	10·757	+0·09
υ^1 Eridani	4 8 27·c3	51·85	+2·2595	+2·2615	+0·001	34 25 26·1	52·0	9·385	9·200	+0·01
α Reticuli	4 11 16·39	51·85	0·7239	0·7378	+0·004	63 6 14·1	52·0	9·167	9·105	+0·02
δ Cœli	4 23 11·95	51·92	1·8280	1·8311	−0·004	45 30 11·6	52·0	8·225	8·071	0·00
υ^7 Eridani	4 25 50	...	...	...	...	31 5 25·8	52·0	8·015	7·817	−0·01
α Doradûs	4 28 36 83	51·82	+1·2711	+1·2774	+0·010	55 34 29·2	52·1	7·790	7 681	+0·11
δ Mensæ	4 35 43·74	51·92	−4·6121	−4·4399	+0·005	80 46 13·8	52·0	7·213	7·594	+0·07
α Columbæ	5 30 36·35	51·94	+2·1674	+2·1690	−0·001	34 13 24·0	52.5	2·567	2·369	−0·02
β Doradûs	5 31 29·47	51·97	0·5027	0·5078	−0·003	62 39 29·6	52·1	2 490	2·443	+0·05
β Columbæ	5 42 9·68	51·92	+2·1051	+2·1068	+0·001	35 52 42·7	52·5	+1·560	+1·367	−0 06
ν Doradûs	6 10 21·74	51·98	−0·3732	−0·3742	−0·020	68 47 14·7	52·1	−0·907	−0·874	+0·04
ζ Canis Majoris	6 10 43	...	...	...	...	29 58 11·5	52·2	0·938	1·145	+0·01
3 Canis Majoris	6 12 59·31	51·94	+2·1916	+2·1929	−0·006	33 19 37·4	52·1	1·137	1·335	−0·03
α Argûs	6 18 24·34	51·74	1·3277	1·3285	+0·002	52 34 10·3	52·2	1·610	1·729	+0·04
ν Argûs	6 30 6·87	51·94	1·8335	1·8344	+0·001	42 59 30·7	52·2	2·629	2·795	+0·04
τ Argûs	6 43 43·77	51·98	1·4861	1·4861	+0·003	50 19 42·9	52·2	3·806	3·938	−0·04
α Pictoris	6 45 37·61	51·97	0·6368	0·6330	−0·018	61 40 40·5	52·2	3·969	4·025	+0·30
π Argûs	7 8 19·04	51·97	+2·1179	+2·1187	−0·001	−36 39 47·7	52·2	−5·893	−6·075	+0·01

Star's Name.	Mean R.A. 1750·0.	Epoch 1700+.	Annual Precession 1750·0.	Annual Precession 1812·5.	Proper Motion in R.A.	Mean Dec. 1750·0.	Epoch 1700+.	Annual Precession 1750·0.	Annual Precession 1812·5.	Proper Motion in Dec.
	h m s		s	s	s	° ′ ″		″	″	″
δ Volantis	7 16 53·14	52·02	+0·0204	+0·0056	−0·004	−67 29 57·6	52·3	−6·606	−6·612	+0·01
σ Argûs	7 21 18·40	51·98	1·9078	1·9082	−0·009	42 48 30·5	52·2	6·970	7·130	+0·20
α Puppis	7 43 37·67	52·06	2·0621	2·0618	−0·001	39 56 39·4	52·2	8·767	8 934	+0·01
ζ Argûs	7 54 48 12	52·06	2·1090	2·1098	−0·003	39 18 44·0	51·3	9 636	9·802	+0·02
γ Argûs	8 1 49·91	52·03	1·8499	1·8500	−0·002	46 36 40·8	52·2	10·171	10·314	+0·01
ε Argûs	8 17 21·38	52·06	+1·2521	+1·2467	−0·002	58 42 52·2	52·2	11·318	11·409	+0·08
α Chamæleontis	8 24 34·27	52·09	−1·3021	−1·3873	+0·020	76 7 12·7	52·3	11·834	11·732	+0·11
ο Argûs	8 33 7·38	52·03	+1·7236	+1·7231	0·000	52 2 36·9	52·2	12·431	12 551	+0·02
δ Argûs	8 37 48·18	52·09	1·6584	1·6573	−0·002	53 48 8·3	52·3	12·750	12·863	−0·07
α Volantis	8 58 26·83	52·09	0·9896	0·9768	−0·006	65 24 10·2	52·3	14·092	14·152	−0·09
λ Argûs	8 58 48·54	52·03	2·2005	2·2032	0·000	42 26 9·2	52·3	14·114	14·254	+0·06
G Carinæ	9 4 19·77	52·12	0·2811	0·2451	−0·018	71 35 49·1	52·3	14·454	14·466	−0·02
β Argûs	9 10 20·94	52·08	0·7574	0·7364	−0 031	68 41 25·5	52·3	14·815	14·857	+0·10
ι Argûs	9 10 23·84	52·12	1·6130	1·6117	−0·005	58 14 8·8	52·4	14·817	14·913	+0·06
κ Argûs	9 14 23·31	52·09	+1·8543	+1·8558	−0·005	53 57 7·6	52·2	15·051	15·158	+0·03
ζ Octantis	9 28 9 32	52·12	−5·6728	−6 4616	−0·104	84 37 26·1	52·3	15·820	15·469	+0·03
υ Argûs	9 40 50·80	52·06	+1·5106	+1·5078	−0·006	63 55 6·6	52·4	16·479	16·553	+0·02
φ Argûs	9 48 7·13	52·09	2·0901	2·0956	−0·004	53 23 14·6	52·3	16·833	16·933	+0 06
ω Argûs	10 7 46·87	52·09	1·4478	1·4447	−0·012	68 48 5 6	52·3	17·708	17·764	+0·02
I Carinæ	10 19 22·00	52·12	+1·2359	+1·2245	−0·003	−72 45 46·5	52·3	−18·162	−18·205	−0·02

Star's Name.	Mean R.A. 1750·0	Epoch 1700+.	Annual Precession 1750·0	Annual Precession 1812·5.	Proper Motion in R.A.	Mean Dec. 1750·0	Epoch 1700+.	Annual Precession 1750·0	Annual Precession 1812·5.	Proper Motion in Dec.
	h m s		s	s	s	° ′ ″		″	″	″
p Carinæ	10 23 11·76	52·09	+2·1044	+2·1141	−0·007	−60 24 22·4	52·3	−18·302	−18·375	+0·04
θ Argûs	10 34 6·05	52·15	2·1050	2·1166	−0·004	63 5 24·5	52·2	18·672	18·737	+0·02
η Argûs	10 35 25·72	52·09	2·2863	2·2992	−0·001	58 22 39·6	52·3	18·715	18·784	+0·06
μ Argûs	10 36 4·51	52·15	2·5360	2·5474	+0·007	48 6 24·0	52·3	18·735	18·812	−0·01
δ^2 Chamæleontis	10 43 11·65	52·15	0·7587	0·7089	−0·039	79 13 21·6	52·3	18·949	18·966	0·00
η Octantis	11 0 15·98	52·12	0·1586	0·0072	−0·070	83 14 49·7	52·4	19·387	19·383	−0·04
Lacaille 4779	11 20 45	...	...	...	...	30 28 35·5	51·7	19·772	19·811	+0·05
λ Centauri	11 24 23·10	52·09	2·6863	2·7125	−0·005	61 38 21·1	52·1	19·824	19·855	+0·01
π^1 Chamæleontis	11 27 9·91	52·15	2·3805	2·4188	−0·040	74 30 49·8	52·4	19·860	19·884	−0·02
ϵ Chamæleontis	11 47 37·45	52·33	2·7614	2·8284	−0·034	76 49 43·5	51·5	20 035	20·043	−0·03
κ Chamæleontis	11 52 16·02	52·26	2·8999	2·9656	−0·053	75 7 46·4	52·4	20 054	20·056	+0·04
λ Chamæleontis	11 55 2·33	52·26	2·9691	3·0329	−0·040	73 58 35·5	52·4	20·060	20·060	+0·04
δ Centauri	11 55 31·04	52·12	3 0394	3·0621	−0·004	49 19 45·8	51·9	20·061	20·060	0 00
ρ Centauri	11 58 42 94	52·26	3·0607	3·0849	−0·007	50 58 35·3	52·4	20·065	20·059	+0·02
δ Crucis	12 2 2·19	52·31	3·0885	3·1196	−0·007	57 21 30·6	52·3	20·064	20·055	+0·04
β Chamæleontis	12 4 16·77	52·29	3·1866	3·2864	−0·034	77 55 18·5	52·4	20·061	20·049	0·00
ϵ Crucis	12 8 2·81	52·29	3·1481	3·1828	−0·024	59 1 13·4	52·4	20·053	20·036	+0 17
α^1 Crucis	12 12 55·28	52·29	3·2100	3·2500	−0·015	61 42 47·5	52·3	20·033	20 010	+0·06
γ Crucis	12 17 27·59	52·29	3·2192	3·2514	+0·005	55 42 45·3	52·3	20·007	19·977	−0·20
γ Muscæ	12 17 54·18	52·31	+3·3689	+3·4359	−0·016	−70 44 53·7	52·3	−20·004	−19·972	−0·01

Star's Name.	Mean R.A. 1750·0. h m s	Epoch 1700+.	Annual Precession 1750·0. s	Annual Precession 1812·5. s	Proper Motion in R.A. s	Mean Dec. 1750·0. ° ′ ″	Epoch 1700+.	Annual Precession 1750·0. ″	Annual Precession 1812·5. ″	Proper Motion in Dec. ″
α Muscæ	12 22 34·65	52·31	+3·3915	+3·4498	−0·006	−67 45 15·7	52·4	−19·969	−19·929	0·00
γ Centauri	12 27 51·40	52·15	3·2474	3·2724	−0·020	47 34 58·8	51·5	19·917	19·874	0·00
β Muscæ	12 31 15·27	52·31	3·4929	3·5510	−0·008	66 44 5·8	52·3	19·879	19·828	0·00
β Crucis	12 33 18 28	52·29	3·3837	3·4211	−0·001	58 19 8·5	52·4	19·854	19·803	+0·05
δ Muscæ	12 45 29·45	52·31	3·8023	3·8816	+0·061	70 11 37·0	52·4	19·671	19·594	0·00
ι Centauri	13 6 37·99	51·40	3·3423	3·3606	−0·028	35 23 9·7	51·9	19·223	19·129	−0·06
ε Centauri	13 24 14·18	51·41	3·6892	3·7247	−0·007	52 11 1·3	51·5	18·725	18·596	−0·01
ν Centauri	13 34 37·82	52·26	3·5273	3·5503	−0·006	40 25 52·0	51·5	18·379	18·242	+0·03
μ Centauri	13 34 40·33	52·31	3·5403	3·5640	−0·001	41 13 3·0	51·5	18·378	18·240	+0·03
g Centauri	13 35 3·11	52·26	3·4225	3·4404	−0·004	33 11 29·2	52·5	18·364	18·231	−0·03
k Centauri	13 37 29·62	52·24	3·4114	3·4285	−0·010	31 44 34·8	52·5	18·276	18·141	0·00
ζ Centauri	13 40 5·20	51·41	3·6567	3·6852	−0·006	46 2 44·3	51·5	18·182	18·034	0·00
β Centauri	13 46 26·97	52·24	4·0731	4·1239	−0·009	59 9 2·2	52·5	17·940	17·764	−0·03
δ Octantis	13 50 1·14	52·31	7·7539	8·2939	−0·089	82 29 12·2	52·3	17·797	17·443	0·00
θ Centauri	13 52 3·99	51·41	3·5120	3·5314	−0·045	35 7 37·2	51·6	17·714	17·556	−0·50
ι Lupi	14 3 31·53	52·29	3·7539	3·7817	+0·003	44 53 33·6	51·5	17·220	17·037	+0·13
η Centauri	14 19 44·79	51·40	3·7368	3·7608	−0·002	41 2 34·3	51·5	16·449	16·247	−0·01
α Circini	14 22 39·07	51·41	4·6593	4·7272	−0·033	63 51 47·9	52·5	16·302	16·045	−0·24
α^1 Centauri	14 22 48·26	51·41	4·4103	4·4643	−0·482	59 47 26·1	52·5	16·295	16·052	+0·82
α^2 Centauri	14 22 49·97	51·41	+4·4106	+4·4644	−0·482	−59 47 9·9	52·5	−16·293	−16·050	+0·82

Star's Name.	Mean R.A. 1750·0.	Epoch 1700+.	Annual Precession 1750·0.	Annual Precession 1812·5.	Proper Motion in R.A.	Mean Dec. 1750·0.	Epoch 1700+.	Annual Precession 1750·0.	Annual Precession 1812·5.	Proper Motion in Dec.
	h m s		s	s	s	° ′ ″		″	″	″
α Lupi	14 25 27·26	51·40	+3·8997	+3·9288	−0·007	−46 17 46·3	51·5	−16·158	−15·939	−0·01
β Lupi	14 42 16·56	51·41	3·8561	3·8805	−0·004	42 6 19·2	51·5	15·241	15·006	−0·07
κ Centauri	14 43 0 80	51·46	3·8311	3·8546	−0·002	41 4 50·3	51·5	15·200	14·965	−0·02
π Lupi	14 48 14·65	51·46	3·9996	4·0276	−0·009	46 3 4·0	51·5	14·897	14·645	−0·01
γ Trianguli Australis	14 56 0·32	51·41	5·3385	5·4246	−0·016	67 43 32·2	52·5	14·433	14·085	−0·02
δ Lupi	15 5 3·84	51·41	3·8729	3·8942	−0·002	39 43 13·8	51·5	13·872	13·609	0·00
ε Lupi	15 5 49·46	51·41	3 9987	4·0233	−0·002	43 46 0·9	51·6	13·822	13·552	−0·01
γ Lupi	15 18 34·58	51·41	3·9345	3·9553	0·000	40 18 9·5	51·5	12·993	12·713	−0 01
β Trianguli Australis	15 33 22·94	51·40	5·1424	5·1959	−0·029	62 37 34·6	52·5	11·978	11·594	−0·38
α Trianguli Australis	16 22 28·32	51 41	6·1665	6·2271	+0·002	68 31 24·5	52·5	8·283	7·764	−0 04
ε Scorpii	16 34 1·13	51·41	3·9035	3·9140	−0·050	33 48 41·1	52·1	7·353	7·018	−0·26
μ^1 Scorpii	16 34 59·60	51·46	4·0297	4 0415	−0·003	37 35 22·7	51·6	7·273	6·927	0·00
ζ^2 Scorpii	16 37 3·27	51·49	4·1924	4·2059	−0 013	41 54 5·7	51·6	7·104	6·744	−0·26
ζ Aræ	16 38 2·78	51·49	4·8973	4·9208	−0·012	55 33 36·4	52·1	7·023	6·600	−0 02
ϵ^1 Aræ	16 39 44·94	52·44	4·7218	4·7421	0·000	52 44 32·4	51·5	6·883	6·474	+0·05
η Scorpii	16 54 18·11	51·49	4·2613	4·2727	−0·001	42 52 44·6	51·6	5·673	5·299	−0·25
γ Aræ	17 4 25·58	51·49	5·0028	5·0196	−0·002	56 6 21·6	52·5	4·818	4·372	+0·04
β Aræ	17 4 35·22	51·49	4·9425	4·9587	−0·002	55 15 24·9	51·6	4·804	4·365	0·00
δ Aræ	17 8 36·91	51·49	+5·3690	+5·3886	−0·011	−60 26 4·6	52·5	−4·461	−3·981	−0·09

Star's Name.	Mean R.A. 1750·0.	Epoch 1700+.	Annual Precession 1750·0.	Annual Precession 1812·5.	Proper Motion in R.A.	Mean Dec. 1750·0.	Epoch 1700+.	Annual Precession 1750·0.	Annual Precession 1812·5.	Proper Motion in Dec.
	h m s		s	s	s	° ′ ″		″	″	″
α Aræ	17 12 33·74	51·47	+4·6105	+4·6214	−0·004	−49 38 38·2	51·6	−4·123	−3·710	−0·03
υ Scorpii	17 13 47·91	51·52	4·0599	4·0667	−0·002	37 3 59·6	51·6	4·017	3·653	0·00
λ Scorpii	17 16 39·56	51·64	4·0561	4·0625	−0·001	36 53 32·2	51·6	3·772	3·406	+0·01
θ Scorpii	17 19 23·24	51·41	4·2896	4·2969	−0·001	42 48 28·8	51·6	3·537	3·151	+0·06
η Pavonis	17 21 16·51	51·49	5·8412	5·8603	−0·007	64 33 27·9	52·2	3·374	2·847	−0·10
κ Scorpii	17 25 13·17	51·49	4·1358	4·1414	−0·003	38 52 19·3	51·6	3·034	2·659	+0·05
ι¹ Scorpii	17 30 7·98	51·40	4·1827	4·1879	−0·007	39 59 54·4	51·5	2·607	2·227	0·00
γ¹ Sagittarii	17 49 3·68	51·52	3·8280	3·8296	−0·003	29 33 45·2	51·6	0·957	0·608	+0·02
γ² Sagittarii	17 49 45	...	...	...	...	30 23 53·5	51·6	−0·897	−0·546	−0·17
η Sagittarii	18 0 42·86	51·41	4·0709	4·0713	−0·013	36 48 25·8	51·6	+0·063	+0·433	−0·13
δ Sagittarii	18 4 58	...	...	...	...	29 54 18·0	51·6	0·435	0·785	−0·03
ε Sagittarii	18 7 34·91	51·41	3·9878	3·9875	−0·007	34 28 19·6	52·2	0·664	1·027	−0·13
α Telescopii	18 8 25·66	51·55	4·4577	4·4563	−0·004	46 4 21·8	51·7	0·738	1·145	−0·04
ζ Pavonis	18 13 43·08	52·44	7·0812	7·0653	−0·007	71 35 18·7	51·7	1·200	1·843	−0·18
ζ Sagittarii	18 46 41	...	...	...	...	30 12 35·6	51·6	4·059	4·399	+0·02
β¹ Sagittarii	19 4 36·57	51·59	4·3501	4·3389	0·000	44 53 48·3	51·7	5·582	5·962	−0·04
β² Sagittarii	19 5 5·92	51·59	4·3647	4·3533	+0·007	45 14 18·8	51·7	5·623	6·002	−0·06
α Sagittarii	19 6 30·83	51·59	4·1864	4·1766	+0·004	41 3 26·3	51·7	5·742	6·104	−0·09
ε Pavonis	19 31 11·41	51·55	+7·2393	+7·1435	+0·013	−73 31 24·1	51·7	+7·775	+8·372	−0·11

Star's Name.	Mean R.A. 1750·0.	Epoch 1700+.	Annual Precession 1750·0.	Annual Precession 1812·5.	Proper Motion in R.A.	Mean Dec. 1750·0.	Epoch 1700+.	Annual Precession 1750·0.	Annual Precession 1812·5.	Proper Motion in Dec.
	h m s		s	s	s	° ′ ″		″	″	″
δ Pavonis	19 43 55·62	51·55	+5·8729	+5·8152	+0·195	−66 46 49·1	51·7	+8·789	+9·264	−1·13
α Pavonis	20 5 41·37	51·55	4·8622	4·8258	+0·002	57 30 26	...	...	...	...
α Indi	20 19 51·79	51·59	4·2932	4·2687	+0·005	48 8 21·3	51·7	11·499	11·815	+0·11
β Pavonis	20 22 4·54	51·59	5·6434	5·5712	−0·006	67 4 7·3	52 0	11·654	12·067	0·00
β Indi	20 35 3·43	51·59	4·8316	4·7858	−0·001	59 22 19·6	51·8	12·563	12·899	+0·02
γ Pavonis	21 5 24·49	51·55	5·1905	5·1134	+0·010	66 28 17·4	52·2	14·519	14·835	+0·78
ν Octantis	21 12 31	...	...	...	...	78 28 1·1	51·8	14·942	15·375	−0·26
γ Gruis	21 38 42·41	51·55	3·6857	3·6659	+0·005	38 31 31·7	51·8	16·371	16·558	−0·02
α Gruis	21 52 20·60	51·59	3·8597	3·8303	+0·010	48 9 29·1	51·8	17·032	17·210	−0·13
α Toucani	22 1 7·13	51·59	4·2917	4·2354	−0·011	61 29 35·2	52·0	17·426	17·610	+0·01
β Octantis	22 18 34·92	51·75	7·5251	7·0361	−0·056	82 40 24·5	52·3	18·132	18·404	−0·03
β Gruis	22 27 36·53	51·59	3·6565	3·6282	+0·013	48 10 58·4	51·8	18·457	18·580	+0·01
τ Octantis	22 30 25	...	...	...	...	88 49 56·8	52·2	18·552	...	−0·02
α Piscis Australis	22 43 46	...	...	...	...	30 56 24·2	51·8	18·965	19·057	−0·17
γ Toucani	23 2 39·09	51·73	+3·6345	+3·5920	−0·007	59 36 0·8	52·1	19·440	19·514	+0·06
γ^1 Octantis	23 36 35	...	...	...	...	−83 24 27·2	52·5	+19·960	+19·990	0·00

Blackheath:
May 10, 1888.

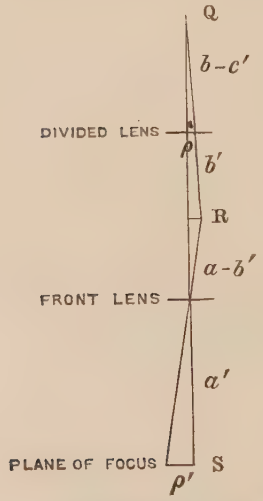
On the Condition that in a Double-Image Micrometer the value of a Revolution of the Micrometer Screw be independent of the Accommodation of the Eye. By Professor J. A. C. Oudemans.

Putting the focal lengths of the lenses of the micrometer (beginning from the object-glass), p, q, r, s; the intervals between the lenses (in the same order), a, b, c; then the proportions pointed out by Valz, adopted by Sir G. Airy, and by the constructors, Messrs. Troughton and Simms, are (*Monthly Notices*, vol. x. p. 161):

Focal length of front lens $= p =$ arbitrary,*
" divided lens $= q = -1$,
" field-glass $= r = +1$,
" eye-glass $= s = +1$,
Interval between front and divided lens $a = p$,
" divided lens and field-glass $b = 1$,
" field-glass and eye-glass $c = 3$.

Supposing the eye to be hypermetropic, so that it accommodates for rays converging to a point lying behind the eye-glass at a distance D, then, if we follow the rays of light from the eye to the focus of the micrometer, these rays, after passing each lens, will intersect the axis successively in four points, P, Q, R, S; if we put the distances of these points beyond the lastly passed lens, $= D'$, c', b', and a', these values all depend on D.

Let ρ be the distance between two successive turns of the micrometer screw, and ρ' the corresponding quantity in the measured object, we have



$$\frac{\rho'}{\rho} = \frac{a'}{a-b'}\left(1+\frac{b'}{b-c'}\right)$$

or, putting $b - c' = e$,

$$\frac{\rho'}{\rho} = \frac{a'}{a-b'}\left(1+\frac{b'}{e}\right);$$

but

$$b' = \frac{eq}{e-q},$$

thus

$$1+\frac{b'}{e} = \frac{e}{e-q} = \frac{1}{1-\frac{q}{e}},$$

$$a' = \frac{(a-b')p}{a-b'-p} \qquad \frac{a'}{a-b'} = \frac{p}{a-b'-p}$$

$$\frac{\rho'}{\rho} = \frac{p}{a-\frac{eq}{e-q}-p} \cdot \frac{1}{1-\frac{q}{e}} = \frac{p}{(a-p)\left(1-\frac{q}{e}\right)-q}.$$

* In the micrometer, constructed by Messrs. Troughton and Simms for the Leyden Observatory, in 1855, there are four front lenses, giving four magnifying powers, and having a focal length of 1, $\frac{3}{4}$, $\frac{1}{2}$, and $\frac{1}{3}$. The inch seems to have been taken as unity.

From this expression it follows that, in order that $\frac{\rho'}{\rho}$ be independent of e, and consequently of D, we ought to have $a=p$, a condition already fulfilled in the micrometer, with the intention of obtaining an equal division of light upon the two segments of the divided lens.

Taking $D=\infty$, i.e. supposing the eye accommodated for parallel rays, we have, in the construction adopted by Sir George Airy,

$$D'=s=1,$$
$$c-D'=2,$$
$$c'=2,$$
$$e=b-c'=-1,$$
$$\frac{q}{e}=1.$$

Now in the denominator of the expression found for $\frac{\rho'}{\rho}$, the multiplier of $a-p$ is $1-\frac{q}{e}$, and, consequently, if the equation $\frac{q}{e}=1$ be really satisfied, this multiplier is $=0$.

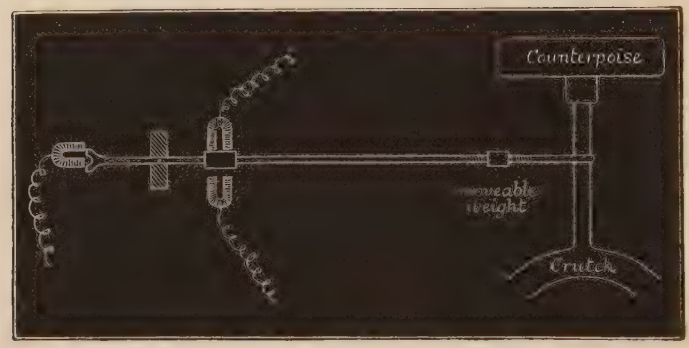
Generally a will not be *exactly* $=p$, and q will not be *exactly* $=e$, but the product of the two factors, $a-p$ and $1-\frac{q}{e}$, will always be very small in comparison with q, so that we may safely conclude that: *in a double-image micrometer, constructed according to the proportions originally pointed out by Valz, the value of one revolution of the micrometer screw is practically independent of the accommodation of the observer's eye.*

In the papers, published by Sir George about this micrometer, I have not found that this point was attended to. Of course, if the images are not very distinct, it is always allowed to thrust in or draw out the eye-tube, containing the field and eye glasses together, but there might remain a doubt whether, if a normal eye has adjusted the micrometer to the focus of the telescope, a hypermetropic or a myope would be justified in changing the distance between the object-glass of the telescope and the whole micrometer. By the above consideration this question is answered in the affirmative.

Utrecht:
1888, *May* 9.

Note on a Simple Method of applying Electrical Control to the Driving Clock of an Equatorial. By A. C. Ranyard, M.A.

As considerable attention is at present being paid to the methods of controlling driving clocks of equatorial telescopes by the motion of a seconds pendulum, I think that a notice of a simple addition which I am having made to my driving clock may be of interest. I am getting rid of my old driving wheel, and propose to substitute a driving sector of 3-foot radius in its place. This gears into an endless screw driven, as in Sir Howard Grubb's clock, by an axis on which is an insulated wheel with rubbers nearly similar to the contrivance described by Lord Crawford and Dr. Gill in the *Monthly Notices* for



November 1873. Instead of the epicycloidal accelerating and retarding wheels used by Sir H. Grubb, I propose to make use of the instantaneous current to act upon magnets which move a small weight attached to the end of a lever backwards or forwards from one side to the other of the fulcrum of the crutch which rubs upon the governor disc. When the little weight attached to the lever is on one side of the fulcrum it decreases the pressure of the crutch, and accelerates the motion of the governor, and when drawn to the other side it increases the pressure and retards the motion of the clock. When the clock is going correctly a magnet draws the lever to the central position over the fulcrum. My governor is similar to that figured by Mr. Common in the *Memoirs*, in describing the mounting of his great 37-inch reflector.

If it is preferred, the height of the fulcrum with respect to the rubbing disc of the governor can be altered by moving a lever attached to an adjusting screw supporting the fulcrum. But the weighted lever above described gives an additional means of adjustment, as a small nut running on a screw, and acting as a counterpoise weight, may be moved upon the lever, or the position of the horseshoe magnets may be moved within certain limits, either towards or away from one another, or up to or away from the centre of motion of the lever.

Observations of Sappho, made at the Cambridge Observatory by Mr. A. Graham with the Northumberland Equatorial and Square Bar-Micrometer.

(*Communicated by Professor J. C. Adams.*)

	Greenwich Mean Time.	Apparent R.A.	Apparent Decl.	Reduction to Geoc. Place in R.A.	Reduction to Geoc. Place in Decl.	Compared Star.	No. of Comps.	Correction of Ephemeris in R.A.	Correction of Ephemeris in Decl.
		h m s	° ′ ″	s	″			s	″
1888, April	14·39868	13 18 25·38	−12 8 0·05	−0·12	+4·66	*a*	10	+6·69	−34·34
	·39868	13 18 25·55	−12 7 57·53	−0·12	+4·66	*b*	10	+6·86	−31·82
	16·40366	13 16 34·05	−11 50 42·34	−0·11	+4·68	*c*	1	+6·52	−31·55
	·40366	13 16 34·57	−11 50 43·06	−0·11	+4·68	*d*	1	+7·03	−32·27
	18·39188	13 14 45·35	−11 33 29·92	−0·11	+4·65	*e*	10	+6·82	−31·98
	30·46232	13 4 35·66	−9 50 50·03	+0·04	+4·66	*f*	5	+6·64	−35·49
	·46536	*g* −0 54·84	*g* +4 23·16	+0·04	+4·66	*g*	4		

Mean Places of Compared Stars for 1888·0, *with Reductions to Apparent Place.*

	R.A. 1888·0.	Decl. 1888·0.	Reduction to Apparent Place in R.A.	in Decl.	Authorities.
	h m s	° ′ ″	s	″	
a	13 16 13·16	−11 59 31·23	+1·31	−5·86	B. (W.) 13h, 230.
b	13 20 48·23	−12 7 26·43	+1·31	−5·70	Greenwich Catalogue for 1872, 1230.
c	13 13 42·57	−11 53 37·34	+1·31	−6·04	B. (W.) 13h, 193.
d	13 14 6·57	−11 52 45·88	+1·31	−6·04	B. (W.) 13h, 202.
e	13 12 56·35	−11 25 30·00	+1·31	−6·14	Place given in Mr. Bryant's Ephemeris.
f	13 8 52·92	− 9 46 31·73	+1·31	−6·40	Argentine Catalogue 18023.
g	13 5 28·96	− 9 55 5·45	+1·30	−6·54	By 4 comparisons with (*f*) April 30.

On April 26, probably by some mistake in giving the time, a small star was observed instead of the planet. The places of several stars, deduced from 11 comparisons, with B. (W.) 13h·34 on that night may be useful to other observers.

	R.A. 1888·0.	Decl. 1888·0.	Mag.	Reduction to Apparent Place in R.A.	in Decl.
	h m s	° ′ ″		s	s
Assumed place of B. (W.) 13h·34	13 5 25·63	−10 30 29·78	9	+1·31	−6·57
	13 6 33·79	−10 25 6·44	9	+1·31	−6·51
	13 6 50·98	−10 25 28·13	12	+1·31	−6·51
	13 8 52·82	−10 27 9·38	9·6	+1·31	−6·43

Note.—The places of the above stars of comparison, as well as those of the stars in Mr. Bryant's Ephemeris, have been observed with the Cambridge Transit Circle, but the observations have not yet been reduced.

Cambridge Observatory: 1888, *May* 3.

Occultations of Stars observed during the Lunar Eclipse of 1888, *January* 28. By E. Nevill, Government Astronomer.

By mischance we did not receive until two days after the eclipse the list of phenomena calculated for this observatory by Dr. Döllen, and so were dependent for our information on a copy of the list of stars occulted at the Cape, which was forwarded to us by Dr. Gill a few days before the eclipse.

The observations were made by myself with the 8-inch Grubb Refractor, power 125, the times being noted and recorded by my assistant, Mr. Grant

The Moon's limb, though eclipsed, was too bright to enable stars of the 10th or 11th magnitude to be observed with any certainty.

Star. No. on Döllen's List.	Phenomena.	Observed Greenwich Mean Time. h m s	Star. No. on Döllen's List.	Phenomena.	Observed Greenwich Mean Time. h m s
86	Reapp.	10 40 42·0	143	Disapp.	11 12 5·2
129	Disapp.	44 8·1	147	Disapp.	18 27·7
127	Disapp.	48 49·6	95	Reapp.	20 38·8
122	Disapp.	50 23·8	159	Disapp.	33 25·4
76	Reapp.	11 1 51·3	122	Reapp.	59 42·6
88	Reapp.	3 3·5	169	Disapp.	12 3 10·9
68	Reapp.	4 17·8	179	Disapp.	5 30·2
*	Disapp.	9 29·7	127	Reapp.	10 1·9
140	Disapp.	9 53·2			

In all 17, or 10 disappearances and 7 reappearances.

Natal Observatory :
1888, *April* 4.

Observation of the Occultation of Venus by the Moon, 1888, March 9. By John Tebbutt.

Having on the evening of the 10th instant completed a set of filar-micrometer measures of the position of the comet now visible, I turned the 8-inch telescope on the Moon to observe the occultation of *Venus*, then shining brilliantly, immediately beneath the lunar crescent. The magnifying power employed for the observation was 130 diameters, and the sky was fortunately beautifully clear. As there was considerable undulation along the Moon's limb in consequence of her low altitude I could not observe the disappearance with satisfaction. The planet's terminator was noted to be in contact with the Moon's limb at $17^h\ 34^m\ 21^s{\cdot}3$ local mean time, but to my surprise the illuminated portion of the planet's disc, instead of disappearing, advanced gradually on the lunar disc till it was fully half projected on it, then suddenly at $17^h\ 34^m\ 43^s{\cdot}8$ the projected portion of the disc disappeared, and the planet assumed a semicircular form with the Moon's limb as the diameter. The total disappearance of the planet was noted as accurately as possible at $17^h\ 34^m\ 57^s{\cdot}7$. There was a remarkable contrast between the brilliancy of the planet and that of the Moon's limb, the former being by far superior. The reappearance was observed with the same telescope and magnifying power. The disappearance itself was a most interesting phenomenon, but the reappearance was still more interesting and indeed striking. The planet's terminator shot out from the grey sky in the field of the telescope as a brilliant streak at $18^h\ 56^m\ 18^s{\cdot}6$. The definition was good, and the objects more steady than at the disappearance. The gradual progress of the Moon's dark limb over the planet's illuminated disc was watched with interest, and at $18^h\ 56^m\ 44^s{\cdot}8$, but probably a second late, the last contact of limbs occurred. I believe this is the first occultation of *Venus*, and the fourth of a bright planet that I have witnessed during an experience of more than thirty years.

Windsor, N. S. Wales:
1888, *March* 14.

Observations of Comet 1888 a (Sawerthal) made at the Royal Observatory, Greenwich.

(*Communicated by the Astronomer Royal.*)

The observations were made with the East or Sheepshanks Equatorial, aperture 6·7 inches, by taking transits over two cross wires at right angles to each other, and each inclined 45° to the parallel of declination.

Comet 1888 a (Sawerthal).

Greenwich Mean Solar Time. 1888.	h	m	s	Observer.	⌿−✶ R.A. m	s	Corr. for Par. and Refraction in R.A. s	⌿−✶ N.P.D. ′	″	Corr. for Par. and Refraction in N.P.D. ″	No. of Comp.	Apparent R.A. h	m	s	Apparent N.P.D. °	′	″	Comp. Star.
April 18	15	44	15	HT.	+4	5·80	−0·30	− 3	8·9	−4·8	4	22	52	40·40	70	56	50·1	*a*
18	15	44	15		+3	9·05	−0·30	− 5	30·7	−4·9	4	22	52	40·35	70	56	42·0	*b*
18	15	51	43		+4	8·75	−0·30	+ 3	28·5	−4·1	2	22	52	41·55	70	56	32·3	*c*
26	15	16	4	HT.	+1	4·90	−0·30	− 5	6·5	−4·4	6	23	13	34·00	65	39	22·8	*d*
26	15	16	4		−2	25·43	−0·30	− 0	45·4	−4·1	6	23	13	34·27	65	39	24·1	*e*
26	15	16	31		+3	28·85	−0·30	− 0	48·0	−4·1	2	23	13	33·75	65	39	31·0	*f*
26	15	16	31		+3	7·90	−0·30	−11	2·4	−4·8	2	23	13	33·50	65	39	26·1	*g*
29	14	16	33	L.	+0	14·21	−0·30	+ 0	16·2	−4·2	17		...			...		*h*
29	14	30	56		+0	2·92	−0·37	− 8	13·2	−5·1	6	23	20	52·55	63	55	7·7	*i*
29	14	49	16		+2	16·75	−0·30	− 2	11·4	−4·3	4	23	20	57·65	63	54	33·9	*j*
May 3	15	13	20	HT.	−0	9·13	−0·30	− 0	0·5	−3·6	6	23	30	33·57	61	43	21·1	*k*
4	15	5	55	HT.	+1	1·98	−0·30	− 4	1·8	−3·7	4		...			...		*l*
4	15	17	10		−5	26·65	−0·30	− 3	28·5	−3·7	4	23	32	54·00	61	12	11·1	*m*
5	13	53	28	HT.	+6	58·00	−0·30	− 1	5·0	−4·1	3	23	35	3·20	60	43	33·7	*n*
5	13	59	53		+4	0·00	−0·30	+ 5	45·1	−3·3	2		...			...		*o*
7	13	28	15	H.	−0	6·30	−0·30	+ 0	4·8	−4·1	1		...			...		*p*
10	13	54	2	T.	−1	3·50	−0·30	+ 3	32·6	−3·4	6	23	46	25·80	58	16	33·9	*q*

Mean Places of Comparison Stars.

	Star's Name.	R.A., 1888·0. h m s	N.P.D., 1888·0. ° ′ ″	Authority
a	W.B. (2) XXII. 1087	22 48 35·64	70 59 53·7	Lamont.
b	W.B. (2) XXII. 1109	22 49 32·42	71 2 7·6	Lamont.
c	Arg. Zone + 18°, No. 5064	22 48 33·90	70 52 57·9	Lamont.
d	W.B. (2) XXIII. 219	23 12 30·00	65 44 22·8	Weisse's Bessel (2).
e	W.B. (2) XXIII. 291–2	23 16 0·72	65 40 2·6	Weisse's Bessel (2).
f	Arg. Zone + 24°, No. 4738	23 10 5·90	65 40 12·1	Rümker.
g	W.B. (2) XXIII. 169–70	23 10 26·61	65 50 22·4	Weisse's Bessel (2).
h	Arg. Zone + 25°, No. 4935	23 20 42	63 54	Bonn Observations, Vol. IV.
i	Arg. Zone + 25°, No. 4936	23 20 50·65	64 3 14·9	Bonn Observations, Vol. VI.
j	W.B. (2) XXIII. 350	23 18 41·87	63 56 38·5	Weisse's Bessel (2).
k	W.B. (2) XXIII. 621–2	23 30 43·60	61 43 13·7	Weisse's Bessel (2).
l	Arg. Zone + 28°, No. 4608	23 31 48	61 19	Bonn Observations, Vol. IV.
m	78 Pegasi	23 38 21·46	61 15 31·9	Greenwich 9-Year Catalogue.
n	W.B. (2) XXIII. 566	23 28 6·06	60 44 31·3	Weisse's Bessel (2).
o	Arg. Zone + 29°, No. 4969	23 31 3	60 38	Bonn Observations, Vol. IV.
p	Arg. Zone + 30°, No. 5015	23 39 36	59 33	Bonn Observations, Vol. IV.
q	Lalande 46809	23 47 30·12	58 12 52·9	Lalande.

Notes.

April 26.—Nucleus only visible; no trace of a tail could be seen in the strong moonlight and approaching daylight.

May 3.—The comet became very faint towards the end of the series of observations; tail visible at first.

4.—Comet very faint at last comparison.

5.—Comet not at all easy to observe; tail traceable for 20′.

7.—This observation was made during a break in the cloud; comet had a distinct nucleus, and a very perceptible tail.

10.—Comet faint, with long, straight, but very faint tail.

The observations are corrected for parallax and refraction. The initials HT., T., L., H. are those of Mr. Turner, Mr. Thackeray, Mr. Lewis, and Mr. Hollis respectively.

Observation of Comet 1888 *a* (*Sawerthal*) *with the Altazimuth.*

From an observation of Comet *a*, made on the morning of May 2, with the altazimuth, with the graduated face of the vertical circle left, the following position, corrected for parallax and refraction, was obtained:—

Greenwich Mean Solar Time.	Observer.	R.A.	N.P.D.
1888. h m s		h m s	° ′ ″
May 1 13 34 35	T.	23 25 40·57	62 50 35·0

Observations of the Spectrum of Comet 1888 *a* (*Sawerthal*), *made at the Royal Observatory, Greenwich.*

(*Communicated by the Astronomer Royal.*)

The comet was looked for on several mornings, but owing to the prevalence of cloud in the east before sunrise was only seen on three occasions.

On April 10 a momentary glimpse was caught of the comet between heavy clouds and through light cloud. The spectrum was of the last degree of faintness, and was supposed at the time to consist simply of the green band of the usual cometary spectrum, without any trace of a continuous spectrum. The observations on April 19 and May 3 render it probable that what was seen was simply the brightest part of the continuous spectrum.

On April 19 the comet was seen again, but still with great difficulty, and always through cloud; the daylight, too, had begun to be strong before the comet could be seen at all.

The spectrum of the comet was mainly continuous. The spectrum, as seen, was probably from the nucleus and immediate neighbourhood only, but, so far as it could be traced, was almost entirely of a continuous character. Two feeble bands were just glimpsed, nearly, if not quite, coincident with the green and yellow bands of the spectrum of the Bunsen flame. The blue band could not be quite satisfactorily made out in the spectrum of the comet, but there seemed some feeble brightening in its neighbourhood, that might be taken as an indication of its presence. Finally, a very fair direct comparison was obtained in the case of the green band, which left no doubt of its coincidence with the corresponding band of the spectrum of the Bunsen flame.

On May 3 the comet was seen again, this time in a clear sky; and its spectrum was found to be practically wholly continuous. The band spectrum was evidently very much feebler in proportion to the continuous spectrum than on April 19, for no trace of the bands in the yellow and blue could be detected, and the band in the green, though searched for very carefully with every variety of slit-width, could only be very faintly suspected, as a feeble local brightening of the continuous spectrum, from the envelope immediately surrounding the nucleus of the comet. The continuous spectrum ended rather abruptly at, or very near, D. The tail of the comet was traced in the finder as a straight beam of light for a considerable distance from the nucleus, and its spectrum could just be seen in the spectroscope, and apparently was, like that of the head, of a continuous character, differing only from it in being far more faint.

No measures could be obtained on either of the three dates of observation. The observations were made throughout by Mr. Maunder, using the single prism spectroscope mounted upon the 12·8-inch refractor.

Observations of Comet a 1888 (*Sawerthal*), *made at the Radcliffe Observatory, Oxford.*

(*Communicated by E. J. Stone, M.A., F.R.S., Radcliffe Observer.*)

The following observations of Comet Sawerthal were made with the Barclay Equatorial, using the ring-micrometer, with power 100.

1888.	Greenwich Mean Time.	Observer.	Comet − Star (Corrected for Refraction only.) Δ R.A.	Δ N.P.D.	No. of Comps.	Apparent R.A. of Comet.	Log. $p\,\Delta$	Apparent N.P.D. of Comet.	Log. $p\,\Delta$	Comp. Star.
	h m s		m s	′ ″		h m s		° ′ ″		
April 6	15 32 0	W.	+0 24·37	−4 11·0	2	22 18 23·73	9·4784	81 2 1·0	0·7430	1
6	15 34 14	W.	+0 51·73	−4 27·3	4	22 18 23·70	9·4784	81 2 1·7	0·7430	2
May 1	13 18 3	W.	+0 17·47	−0 15·7	12	23 25 38·69	9·3842	62 49 54·0	0·6579	3
1	14 17 58	W.	−4 34·81	+3 9·5	4	23 25 45·09	9·4155	62 48 36·7	0·6174	4
2	13 30 45	R.	+1 54·31	+4 7·4	2	23 28 3·58	9·3930	62 17 9·0	0·6428	5
3	13 59 36	F. B.	−1 25·18	+7 16·9	9	23 30 27·46	9·4078	61 44 58·8	0·6193	6
3	14 47 9	F. B.	−0 11·19	+0 33·5	16	23 30 31·73	9·4167	61 43 58·2	0·5820	7
3	14 47 9	F. B.	−1 20·61	+6 11·5	16	23 30 32·03	9·4167	61 43 53·4	0·5820	6
4	13 35 7	W.	−5 36·23	−1 11·5	10	23 32 44·60	9·3952	61 14 31·2	0·6303	8

Assumed Places of Comparison Stars.

Comp. Star.	Mean R.A. 1888·0.	Reduction to Apparent Place.	Mean N.P.D. 1888·0.	Reduction to Apparent Place.	Authority.
	h m s	s	° ′ ″	″	
1	22 18 0·31	−0·95	81 6 4	+ 8·0	½ (Lamont 6282 + Arg. Zone 8°, No. 4861).
2	22 17 32·92	−0·95	81 6 21·0	+ 8·0	⅓ (Lal. 43671–2 + Lamont 6279 + Armagh II. 3008). Adopted proper motion of +0ˢ·020 in R.A.
3	23 25 21·83	−0·61	62 49 58·5	+11·2	Mean of two measured differences from No. 4 comparison star made with the ring-micrometer.
4	23 30 20·53	−0·63	62 45 16·0	+11·2	Armagh II. 3212.
5	23 26 9·88	−0·61	62 12 50·4	+11·2	Armagh II. 3196.
6	23 31 53·26	−0 62	61 37 30·6	+11·3	Mean of two measured differences from star γ made with the ring-micrometer.
γ	23 24 16·43	−0·61	61 43 8·0	+11·3	½ (Lalande 46006 + W.B. (2) XXIII.–485).
7	23 30 43·54	−0·62	61 43 13·4	+11·3	W.B. (2) XXIII. 621–2 (mean).
8	23 38 21·45	−0·62	61 15 31·4	+11·4	½ {Radcliffe (1860) 2349 + Greenwich (1872) 2223}.

Observers' Remarks.

1888, April 6.—The nucleus dead white, well defined, and elongated, thus

At times I thought the nucleus double. Estimated as brighter than the star *Lal.* 43671–2 by a magnitude. The tail was distinctly visible to the naked eye.

April 15.—Nucleus as bright as an 8 mag. star. The tail well visible to the naked eye, and is nearly 5° long. Estimated as equal to the distance between γ and β *Aquilæ*. (Observer R.)

May 1.—Comet about $\frac{1}{3}$ as bright as on April 6. Invisible to naked eye.
2.—Cloudy. Wind gusty. Comet faint.
3.—Central part of the elongated nucleus observed. The comparison star No. 7 is double, mean observed.
4.—The images to-night diffused at times. Nucleus still elongated.

Observers: W., Mr. W. Wickham; R., Mr. W. H. Robinson; F. B., Mr. F. A. Bellamy.

Radcliffe Observatory, Oxford:
1888, *May* 12.

Observations of Comet a 1888 (*Sawerthal*), *in February and March, made at Launceston, Tasmania. Lat. S.* 41° 26′ 1″. *Long. E.* $9^h\ 48^m\ 31^s$. By A. B. Biggs.

(*Communicated by H. H. Turner.*)

February 25.—L.M.T. $4^h\ 52^m\ 15^s$ A.M.

Comet from Star (?) 8221 *Lacaille.* (*Comet S.P.*)

Greenwich M.T.	Diff. R.A.	Diff. N.P.D.	No. of Meas.	Remarks.
h m s	m s	′ ″		
Feb. 24 7 3 42	−0 8·08	+1 23·2	3	Star uncertain.* Only one measure for position, advancing daylight and haze preventing verification. Nucleus bright, well-defined, and surrounded with considerable coma. Brightness about = comparison star.

March 8.—L.M.T. $4^h\ 37^m\ 7^s$ A.M.

Comet from Star 8546 *Lacaille.* (*Comet N.F.*)

h m s	m s	′ ″		
Mar. 7 6 48 36	+1 22·12	−8 49·8	4	Nucleus sharply defined. Less coma about head. Tail more tapering towards the head. Brightness about = comparison star.

March 11.—L.M.T. $5^h\ 21^m\ 55^s$ A.M.

Comet from Star (?) 8566 *Lacaille.* (*Comet N.F.*)

h m s	m s			
Mar. 10 7 19 14	+(9)* 11	missed		* Minutes uncertain—probably 9 in both cases.
7 33 24	(8)* 14·5	−6 03·7	1	

March 16.—L.M.T. $5^h\ 18^m\ 46^s$ A.M.

Comet from Star 30 *Capri.* (*Comet S.P.*)

h m s	m s	′ ″		
Mar. 15 1 30 15	−3 40·25	+7 47	1	Brightness about = comparison star.

March 18.—L.M.T. $5^h\ 4^m\ 24^s$ A.M.

Comet from Star 29 *Capri.* (*Comet S.F.*)

h m s	m s	′ ″		
Mar. 17 7 15 53	+5 02·5	+2 39·03	4	All good measures. Brightness—Comet ∠ star.

* Much the brightest star in a wide field.

General Remarks.—On other dates circle readings only have been taken for position, but as the telescope has worked somewhat out of adjustment, these are of little value. This has rendered some of the star identifications uncertain.

No reductions have been made in the above measures for refraction, &c. This would be only for the small difference in declination, the telescope being fixed in R.A. for each observation.

In all cases the *brightest* available star has been used.

Telescope, $8\frac{1}{2}$-inch reflector.

Further observations prevented by a succession of cloudy mornings.

Launceston:
1888, *March* 24.

Sextant Observations of Comet a 1888, *extracted from the Meteorological Log, No.* 7120, *kept on board the barque 'Atlantic.'* By Captain R. Belding.

(*Communicated by Captain H. Toynbee.*)

1888, *March* 10, 4 A.M., Lat. 22° 17′ S., Long. 26° 45′ W.—Angular distance from the comet's nucleus

to α Centauri 68° 43′. G.M.T. $6^h\ 56^m\ 24^s$;
to Antares 58° 51′. G.M.T. $7^h\ 2^m\ 24^s$.

March 11, 4 A.M., Lat. 21° 40′ S., Long. 27° 9′ W.—Angular distance from the comet's nucleus

to α Centauri 70° 25′. G.M.T. $6^h\ 8^m\ 15^s$;
to Antares 59° 56′. G.M.T. $6^h\ 3^m\ 25^s$;
to Altair 37° 39′.

The comet appeared to be brighter this morning, and bearing about E. by S. $\frac{1}{2}$ S. (true.)

March 12, 4 A.M., Lat. 20° 57′ S., Long. 27° 5′ W.—Comet has a larger and brighter appearance. Angular distance from comet's nucleus

to Antares 61° 11′. G.M.T. $6^h\ 42^m\ 30^s$;
to α Centauri 72° 12′. G.M.T. $6^h\ 48^m\ 10^s$;
to Altair 36° 42′. G.M.T. $6^h\ 55^m\ 30^s$.

March 14, 4 A.M., Lat. 19° 55′ S., Long. 27° 5′ W.—Comet seen again. The tail appears to be curving more to the S.W. Angular distance from comet's nucleus

to Antares 63° 27′. G.M.T. $6^h\ 39^m\ 40^s$;
to α Centauri 75° 36′. G.M.T. $6^h\ 44^m\ 25^s$;
to Altair 35° 0′. G.M.T. $6^h\ 50^m\ 44^s$.

March 15, 4 A.M., Lat. 18° 31′ S., Long. 27° 28′ W.—Angular distance from comet's nucleus

to Antares 64° 51′. G.M.T. $6^h\ 22^m\ 43^s$;
to α Centauri 77° 14′. G.M.T. $6^h\ 29^m\ 44^s$;
to Altair 34° 20′. G.M.T. $6^h\ 39^m\ 53^s$.

March 17, 4.30 A.M., Lat. 14° 1′ S., Long. 28° 3′ W. (by interpolation)—Angular distance from comet's nucleus

to Antares 67° 26′. G.M.T. $6^h\ 43^m\ 3^s$;
to α Centauri 80° 35′. G.M.T. $6^h\ 50^m\ 58^s$;
to Altair 33° 3′. G.M.T. $6^h\ 57^m\ 35^s$.

The comet's nucleus appeared to be brighter, and also to vary in brightness. The tail looked lighter and thinner.

March 22, 4 A.M., Lat. 1° 59′ S., Long. 28° 49′ W. (by interpolation)—Comet seen again. Angular distance from the nucleus

to Antares 73° 50′. G.M.T. $6^h\ 18^m\ 44^s$;
to α Centauri 88° 35′. G.M.T. $6^h\ 25^m\ 31^s$;
to Altair 31° 27′. G.M.T. $6^h\ 32^m\ 56^s$.

March 24, 4 A.M., Lat. 0° 39′ N., Long. 29° 38′ W. (by interpolation)—Angular distance from comet's nucleus

to Antares 76° 26′. G.M.T. $6^h\ 59^m\ 10^s$;
to Altair 31° 27′. G.M.T. $7^h\ 3^m\ 51^s$.

Observations corrected for index error only.